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INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, AUSTRIA

SEVENTH MEETING OF THE TECHNICAL ADVISORY COMMITTEE (TAC-7)

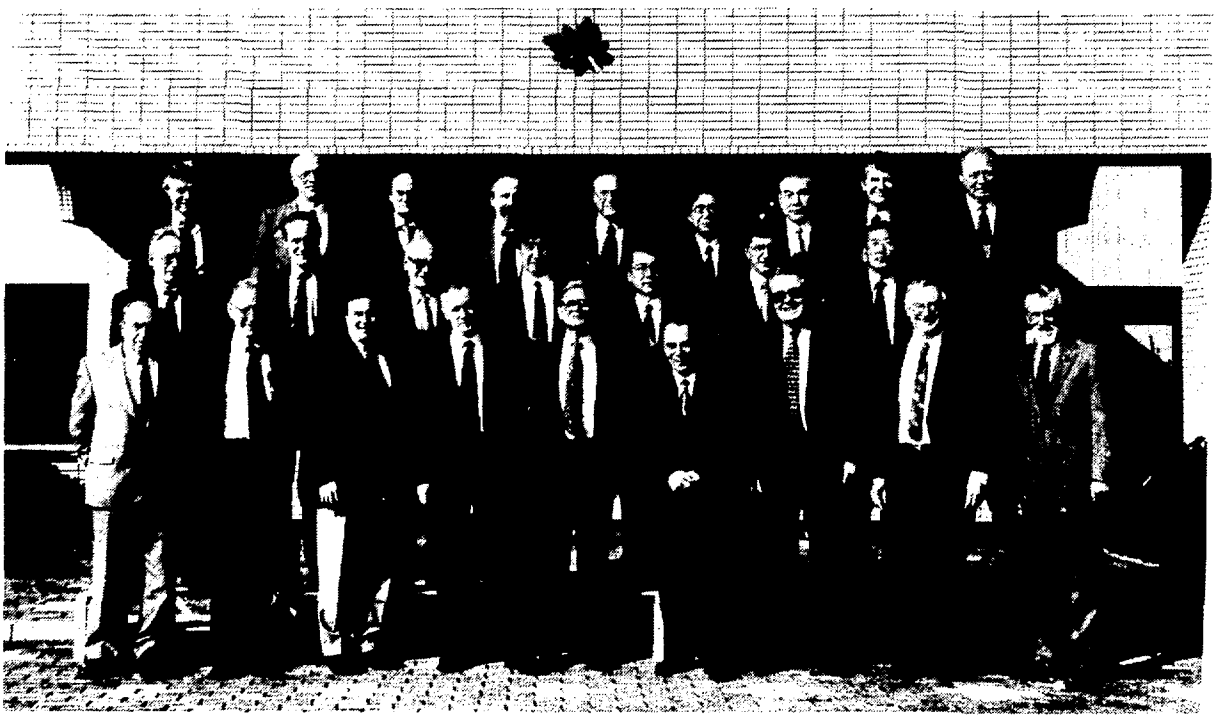
by Prof. P.H. Rutherford, TAC Chair

TAC-7 was held at the ITER Joint Work Site (JWS) Naka, 5–7 December 1994.

A. Evolution of the Design – The ITER Council, at its meeting in Moscow in July 1994, issued the following charge to the TAC in relation to the evolution of the design:

The ITER Council requests the TAC to conduct an informal dialogue with the Director and the JCT on technical progress toward the Interim Design and Cost Review. The purpose will be to allow an informal preliminary review of the evolution of the design. The TAC should document its findings in order to provide appropriate advice and guidance. If possible, this dialogue with the Director and JCT should take place before the next meeting of the ITER Council (IC-7).

A Design Assessment Meeting was held at the JWS San Diego on 17–28 October 1994, involving broad participation from the Joint Central Team (JCT) and the four Home Teams (HTs). The assessment covered all major systems, including safety, vacuum vessel and cryostat, shielding blanket, divertor and plasma-facing components, magnet system and related plasma control, reactor building layout, tritium, assembly



Participants in the Meeting

and remote maintenance. As a result of this assessment, the JCT identified two major systems which should receive near-term design priority, namely the magnet system and the first-wall/shield-blanket; these were seen as the areas in which the greatest evolution of the design from that presented at the TAC-4 meeting is to be expected. In addition, emphasis was to be placed on improved definitions of safety requirements and on the overall machine assembly and remote-maintenance approaches.

On the basis of technical material developed at, and immediately following, this Design Assessment Meeting, the TAC conducted a constructive informal dialogue with the Director and the JCT on the technical progress toward the Interim Design and Cost Review. The TAC noted that several initiatives have been taken by the new Director and the JCT to try to improve the overall machine concept. In essentially all cases, these initiatives are addressing aspects of the design which have been identified as areas of concern by the TAC in the past. In these areas, the design seems likely to evolve in directions consistent with previous TAC recommendations. The TAC also noted the successful efforts to improve co-ordination among the three JWSs. The TAC also noted the progress in the development of a safety plan.

The TAC noted that an intense and focussed effort will be needed between now and the Interim Design and Cost Review in order to finalize the design choices in areas where several options are still under consideration, e.g. the magnets and their supporting structure and the shield/blanket.

The TAC noted the JCT's analysis of the availability of the external supplies of tritium, which has concluded that supplies projected to be available from Canada should be sufficient for the Basic Performance Phase, but that an internal breeding ratio of at least 0.7 will be needed in the Enhanced Performance Phase to meet the minimum fluence objective (1 MW.a/m^2) of this phase.

The TAC also noted an intention to postpone the choice of a heating and current drive method until the end of 1996. It is the TAC's view that the procedures and criteria to be used in making the final selection of a heating and current drive system should be defined by the time of the Interim Design and Cost Review. The TAC noted the JCT's intention to address compatibility issues in order to ensure that the design does not preclude certain attractive heating and current drive options.

The TAC also documented a number of findings on specific design systems, including:

- magnet system, including mechanical structures and magnet assembly;
- poloidal field system, including plasma control;
- shield/blanket;
- divertor and plasma-facing components;
- operational requirements and tritium supply;
- safety.

B. Preliminary Plan for Conducting the Interim Design and Cost Review – The ITER Council, at its meeting in Moscow in July 1994, also issued the following charge to the TAC:

The ITER Council also requests the TAC to prepare a preliminary plan, it consultation with the Director, for conducting the Interim Design and Cost Review, including the participation of an appropriate number of design and costing experts from each Party. The intent is to ensure a thorough and detailed review of each of the ITER systems, including costs, by separate sub-committees of experts. The TAC Chair should consult with each Party through a person designated for this purpose on the naming of appropriate experts. The TAC Chair should present this preliminary plan for consideration by the ITER Council at its next meeting (IC-7).

In response to this charge, the TAC, in consultation with the Director, formulated both an overall approach to the Interim Design and Cost Review (IDCR) and a specific schedule for the various elements of the review.

The overall objective of the Interim Design and Cost Review (IDCR) will be to achieve a robust consensus between the JCT/HTs and the Parties on the design and its cost estimate.

The design to be reviewed at the IDCR will be presented by representatives of the JCT and four HTs, jointly, as determined by the Director.

As suggested by the ITER Council, the IDCR will include the participation of an appropriate number of design and costing experts from each Party.

The IDCR itself should be preceded by in-depth informal reviews of technical aspects of the design involving the Director and JCT, the TAC members, and a number of experts including those designated to participate in the IDCR. These informal reviews should occur at the time when definitive choices among various design options are to be finalized. The purpose of these informal reviews is to provide early technical feedback and to facilitate consensus building on these design choices in advance of the IDCR itself. These informal review should be carried out at the site where the work is being performed, so as to maximize the availability of detailed technical information. Accordingly, there should be two such informal reviews, one at the JWS responsible for in-vessel systems, which will include plasma interactions and physics issues relating to in-vessel systems, and the other at the JWS responsible for ex-vessel systems, which will include plasma control and physics issues relating to ex-vessel systems.

The IDCR itself should be held at the JWS at San Diego and cover all systems/sub-systems and their costing.

Consistent with this overall approach, a tentative schedule for the IDCR, including various preparatory steps, was prepared, as follows:

Date	Event
January 31, 1995	General Requirements Document distributed to the HTs and TAC members for written comment
February 28, 1995	TAC members provide written comments to the TAC Chair on the General Requirements Document
May 1-6, 1995	Informal technical review of In-Vessel Systems including Related Physics, Garching JWS
May 10-14, 1995	Informal technical review of Ex-Vessel Systems including Related Physics, Naka JWS
May 15, 1995 (approximately)	Costing document distributed by JCT to HTs for informal, in-confidence feedback
June 16, 1995	Interim Design and Cost Report distributed
July 2-8, 1995 (excluding July 4)	Interim Design and Cost Review, San Diego JWS
July 26-28, 1995	TAC IDCR Report presented to ITER Council (IC-8), San Diego JWS

LIST OF PARTICIPANTS

TAC Members

EC:	JA:	RF:	US:
R. Andreani	S. Itoh	E. Adamov	J. McCann
D. Robinson	N. Inoue	V. Glukhikh	P. Rutherford (Chair)
F. Troyon	K. Miya	B. Kadomtsev	J. Sheffield
	K. Tomabechi	M. Solonin	

Experts upon nomination of the Parties: O. Filatov (RF), T. Tsunematsu (JA) and K. Wilson (US).

Presentations on behalf of the JCT: R. Aymar, V. Chuyanov, P.-L. Mondino, R. Parker, Y. Shimomura and R. Thome.

C. Flanagan (US) served as Secretary.

SEVENTH MEETING OF THE ITER MANAGEMENT ADVISORY COMMITTEE (MAC-7)

by Dr. M. Yoshikawa, MAC Chair

MAC-7 was held at the ITER Naka Joint Work Site on 30 November and 1 December 1994. This was the first MAC Meeting for Dr. R. Aymar, ITER Director, and Dr. R. Iotti, Administrative Officer. The MAC also invited Dr. Y. Shimomura, Deputy to the Director, and Dr. M. Huguet, Deputy Director and Head of the Naka Joint Work Site. Mr. M. Drew was invited as expert for the JCT.

The MAC reviewed the EDA milestones, the R&D Programme, revised proposals for the 1995 Joint Fund Budget Allocation and Expenditure Plan and proposed a schedule of ITER meetings.

ITER EDA Milestones

The MAC recommended to the ITER Council to confirm that the major milestones to be monitored at the ITER Council level and that their target dates are as follows:

- Interim Design Report, Cost Review, Safety Analysis and Report on Site Requirements (June 1995);
- Detail Design Report, Cost Review and Safety Analysis (December 1996);
- Final ITER Design Report, Cost Review and Safety Analysis (January 1998);
- Comprehensive Report (July 1998).

The MAC noted the change of the following intermediate milestone schedule dates (related to the June 1995 milestone):

- Assessment of full shield blanket replacement – June 1995;
- Definitive choice of heating/current drive system – December 1996.

Participants in the Meeting

ITER R&D Programme Developments and Task Sharing Proposals

An overall plan for the ITER R&D Programme was presented to MAC-6 for review and subsequently submitted to IC-6. As requested by the ITER Council, the Home Team Leaders provided the JCT with comments on the proposals presented to MAC-6. After JCT consideration of these comments and, in the light of issues arising from the design assessment and subsequent discussions with the Home Team Leaders, the R&D Programme items were identified and presented to MAC-7 for review. Taking further developments, in conjunction with the Work Breakdown Structure and the work programme into consideration, the MAC took note of the evolution of the ITER R&D Programme.

The Director and Home Team Leaders discussed a list with general specifications and indications of the ITER credit for the major ITER R&D and design tasks foreseen for the period 1995 and beyond. During the meeting, the Director proposed the following framework of principles in considering Task Sharing Proposals:

1. Tasks should be assigned in larger packages than hitherto;
2. Each R&D task will have a task co-ordinator selected by the Home Team Leaders of the Home Teams participating in the task;
3. For the agreed design tasks, each Party would have one Task Agreement for 1995; individual activities would be subject of specific task orders.

The MAC recommended the ITER Council approval of R&D Task Sharing proposals and Design Task Sharing proposals for 1995.

Revised Proposals for the January – December 1995 Joint Fund Budget Allocation and Expenditure Plan

The MAC recommended the Council to approve the revised proposals for the allocation of the 1995 Joint Fund Budget. MAC also recommended the Council to ask the Director to suspend the planned expenditure for IPMS pending the results of the review of the management systems needed to implement the new management process.

Proposed Schedule of ITER Meetings

The MAC has reviewed the schedule of Technical Meetings and workshops and has agreed to postpone a decision on meetings scheduled after the June milestone until MAC-8 or, in cases of urgency, to submit meeting proposals by written procedure. MAC expressed serious concern about the large number of official meetings (Technical Meetings, Workshops and Expert Group Workshops). It should be recognized that, in addition, numerous informal meetings are indispensable to define details of task sharing and to assess the progress of R&D activities. In order to restrict the number of official meetings, the MAC recommended the ITER Council to request the Director to:

1. consider the present structure of Physics Expert Groups with the aim of reducing their number;
2. adopt criteria to set priorities for meetings such as relevance of the meeting to:
   - choice and assess design solutions of important systems/components of ITER;
   - define the planning and resources related to the main areas of R&D;
   - accomplish the major technical milestones of the EDA.

The MAC tentatively decided that the MAC-8 meeting will be held in San Diego on 9–10 July 1995.

MAGNET TECHNICAL MEETING

by Dr. R.J. Thome, Head, Superconducting Coils and Structures Division, Naka JWS

A Magnet Technical Meeting was held at the Naka Joint Work Site on November 8–11, 1994, with representatives from all ITER Parties attending. A list of participants is shown at the end of this report.

The meeting began with a plenary session in which the JCT presented the results of the ITER Design Assessment (San Diego JWS, October), of the Director and Home Team Leaders Meeting that followed the Design Assessment, as well as an outline of a plan for the activities until July 1995 (completion of the Interim Design Report).

At the Design Assessment, the JCT presented the July 1994 reference magnet system. It included a shear plate design for the TF coils with 2.5 mm turn insulation and a ground wrap over the shear plates. In this configuration, the out-of-plane loads transmitted by the shear keys must pass through the ground wrap. In the event of ground insulation electrical failure, the voltage would then appear across the turn insulation. Hence, the JCT presented at the Design Assessment also a preferred alternative, in which the ground wrap in the reference design was deleted and the turn insulation was increased to 5.5 mm, thus also acting as ground insulation. In addition, the shear pleases would be welded together at the edges, and the plate-to-plate insulation would be deleted, except for possible mechanical filler purposes to make up for tolerances between plates.

The welded shear plate alternative was accepted at the Home Team Leaders Meeting with the Director, as an option to be evaluated along with three others, to arrive at a configuration to be recommended to the Director before the Interim Design Report. The other three options are: a layer or pancake wound winding pack, encased in ground insulation, and, in turn, in a steel case; a shear plate design in which the plates are radially oriented and enclosed in ground wrap and a steel case; and a shear plate design in which the plates are toroidally oriented and enclosed in a steel case. These options are described in more detail below.

In addition to evaluating the four alternatives for the TF coil cross-sectional configuration, all of which retain the "bucked" concept with respect to the central solenoid and bucking cylinder, possible changes to the mechanical structure will be considered and the PF coil supports will be integrated wit the TF coils as opposed to being supported from upper and lower beams as in the July 1994 reference design. This will alter the assembly approach, which will also be evaluated. Furthermore, the installation of shear keys from the vacuum vessel side as opposed to the central solenoid side during machine assembly was the preferred approach presented by the Magnet Division and the Design Integration Division at the Design Assessment. Hence, the Magnet Division will use this approach as a reference. Meanwhile, evaluation of this approach with other ITER Divisions will proceed.

The four TF coil cross-section options will be evaluated by the JCT and the Home Teams, the goal being to reduce the number to one before the next Magnet Meeting, tentatively scheduled for February 7–10, 1995 at Naka. Preliminary dimensions for the cross-sections will be sent to the Home Teams in early December, and iterated periodically as design and analyses activities continue to February and to the Interim Design Report. The Home Teams will prepare now for a Cost Estimating Task to be issued at the February Magnet Meeting. Results from the Cost Estimating Task will be required before the April Magnet meeting (tentatively set for April 18–21 at Naka). Following the April Magnet Meeting, the JCT will prepare a recommendation to the Director for the TF cross-section configuration.

Following the JCT presentation as outlined above, the Home Teams summarized the status of the Cost Estimating Task that is underway based on the July 1994 reference design. A considerable amount of this work, with suitable modifications, is expected to be applicable to the options outlined above. None of the final reports have been received for this task so far. However, the tasks are either well underway or planned to be completed on time.

Home Team representatives then presented results of homework structural analyses on the reference design and on selected design options. These discussions continued in a separate session of the Full Scale Coils Group that led to the general plan and homework.

Meeting Participants at the JAERI CS Model Coil Test Facility (under construction)

Another separate session of a Cost/Planning Group, to which all Home Teams were invited to send a representative, reviewed R&D tasks for 1995 and beyond, and outlined plans for the cost estimating tasks to be performed before the Interim Design Report. A limited analytical effort will also be applied to a wedged design option. This will not be carried beyond the February Magnet Meeting and no cost estimate will be done.

The TF Coil Design Options

Option 1 – consists of a modified form of the reference shear plate design described in the July 1994 Cost Estimating Task. It consists of four grades of a conductor with Incoloy 908 jackets and a turn insulation that has been increased to a thickness of 5.5 mm. This turn insulation also acts as ground insulation so the shear key load is now transmitted directly to steel in the keyway or through a liner for mechanical load redistribution, if this is found to be desirable. Details of the edge design or of the shear plate configuration may change to suit manufacturing requirements. (This is also the situation for the other options.)

Option 2 – consists of using a heavy walled 908 jacketed conductor in a case. Studies will also investigate round vs. square vs. hexagonal conductor sections, and layer vs. pancake windings.

Option 3 – consists of conductor in a round 908 jacket that is supported in radially oriented shear plates enclosed in a case.

Option 4 – consists of a cased design with shear plates oriented in the toroidal directions.

A preliminary list of advantages and disadvantages of these options is given in the following table. The goal of the option comparison will be to quantify these items, if possible, and, in particular, to determine the overall radial build of the TF coil options on a consistent basis.

BUCKED DESIGN OPTIONS

Option	Advantages	Drawbacks
1. Welded shear plates (modified reference design)	- Design and analysis well advanced - Industrial evaluation underway - Higher stress margin on conductor jacket and insulation - No change of R	- Unconventional for TF coils in layers - Welding of plates (distortion, cost) - Depth of weld (to be determined)
2. Case and winding pack with heavy conductor jacket (layers or pancakes)	- Design and analysis in progress - More conventional TF coil design - Small change of R expected	- Lower margin for stress on conductor jacket, turn insulation, and ground insulation
3. Case and plates in pancake configuration	- Partial modularity of design - Possibility of testing individual pancakes during manufacture - Better stress margin on conductor jacket and turn insulation (but not ground insulation) - Higher nuclear heating capability	- Increase of R expected (5-10 cm) - More superconductor (no grading) - High cost of plates - Internal joints between pancakes - Out-of-plane stiffness depends on bond between plates
4. Case and plates in layer configuration	- High bending stiffness in both in-plane and out-of-plane directions - Higher margin for stress on conductor jacket and insulation	- Increase of R expected (5-10 cm) - Design not modular

LIST OF PARTICIPANTS

EU:	JA:	RF:	US:
C.T.J. Jong, ECN	M. Sugimoto, JAERI	E. Bondarchuk, Efremov	F. Kimball, Martin Marietta
P. Komarek, KfK	E. Tada, JAERI	V. Yakubovsky, Efremov	D.B. Montgomery, MIT
E. Salpietro, NET	S. Tado, JAERI		P. Titus, MIT
B. Turck, CEA	Y. Takahashi, JAERI		
	Y. Tsuda, Mitsubishi		
	H. Tsuji, JAERI		

JCT: P. Barabaschi, C.W. Bushnell, B. Green, M. Huguet, F. Iida, Y. Krivchenkov, N. Mitchell, K. Okuno, Z. Piec, C. Sborchia, M. Shimada, B. Stepanov, J. Stoner, R.J. Thome, R. Vieira, F.M.G. Wong, K. Yoshida, E. Zapretilina

FORTHCOMING EVENTS *)

- Second Tritium Plant Technical Meeting, Naka, Japan, 1–3 February
- Magnet Technical Meeting, Naka, Japan, 7–10 February
- Diagnostics Technical Meeting, Naka, Japan, 9–10 February
- Disruptions, Plasma Control and MHD Technical Meeting, Garching, Germany, 13–17 February
- Diagnostic Engineering on In-Vessel Diagnostics (Technical Meeting and Workshop), Naka, Japan, 13–15 February
- Second Power Supply Technical Meeting, St. Petersburg, Russia, 20–24 February

*) Attendance at all ITER Meetings by invitation only.

Items to be considered for inclusion in the ITER Newsletter should be submitted to B. Kouvchinnikov, ITER Office, IAEA, Wagramerstrasse 5, P.O. Box 100, A-1400 Vienna, Austria, or Facsimile: 43 1 237762 (phone 2360 6392).

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